METHOD AND ARRANGEMENT FOR TRANSMITTING AND RECEIVING RF SIGNALS THROUGH VARIOUS RADIO INTERFACES OF COMMUNICATION SYSTEMS

CROSS-REFERENCE TO RELATED APPLICATION(S)

[0001] This application is a continuation of U.S. application Ser. No. 14/272,191, filed May 7, 2014, which is a continuation of U.S. application Ser. No. 13/614,272, filed Sep. 13, 2012, which is a continuation of U.S. application Ser. No. 12/136,465, filed Jun. 10, 2008, which is a continuation of U.S. application Ser. No. 09/856,746, filed May 24, 2001 (issued as U.S. Pat. No. 7,415,247 on Aug. 19, 2008), which is a U.S. national stage of PCT/FI99/00974, filed Nov. 25, 1999, which is based on and claims priority to Finnish application no. 982559, filed Nov. 26, 1998, all incorporated by reference herein.

[0002] The invention relates to a method and arrangement for transmitting and receiving RF signals associated with various radio interfaces of communication systems. The invention finds particular utility in transceivers of general-purpose mobile stations.

[0003] Mobile communication systems are developing and expanding rapidly which has led to a situation in which there are in many areas systems complying with several different standards. This has brought about a need for mobile stations that can be used in more than one system. Good examples are the digital systems called GSM (Global System for Mobile communications) and DCS (Digital Cellular System), which operate on different frequency bands but have otherwise similar radio interfaces. In addition, the modulation, multiplexing and coding schemes used may be different. The systems mentioned above use the time division multiple access (TDMA) method; other methods include the frequency division multiple access (FDMA) and code division multiple access (CDMA).

[0004] One possible way of making a mobile station capable of operating in multiple systems is to have in the mobile station completely separate signal paths for each system. This, however, would lead to an unreasonable increase in the mobile station size and manufacturing costs. Therefore, the goal is to design a mobile station in which the differences relating to the radio interfaces of the various systems could be largely dealt with by means of programming, instead of having separate signal processing paths.

[0005] It is known e.g. from patent application document EP 653851 a transceiver arrangement using one local oscillator the frequency of which falls between the lower operating frequency band and the higher operating frequency band such that one and the same intermediate frequency (IF) can be used for both operating frequency bands. However, the disadvantage of such a solution is that the necessary IF stages make the implementation rather complex, and the manufacturing costs of the device will be high because of the great number of components. Furthermore, the IF stages require filters in order to eliminate spurious responses and spurious emissions. In addition, channel filtering at the intermediate frequency sets great demands on the IF filters.

[0006] In a direct-conversion, or zero-IF, receiver the radio-frequency (RF) signal is directly converted into baseband without any intermediate frequencies. Since no IF stages are needed, the receiver requires only a few components, therefore being an advantageous solution for general-purpose mobile stations which have multiple signal branches for different systems. To aid in understanding the problems relating to the direct conversion technique and prior art it is next described in more detail a prior-art solution.

[0007] FIG. **1** shows a direct conversion based arrangement for realizing a dual frequency band transceiver, known from the Finnish Patent document FI 100286. Depending on the receive frequency band, a RF signal received by an antenna is coupled by means of switch **104** either to a first receive branch (DCS) or second receive branch (GSM).

[0008] If the received signal is in the DCS frequency band, it is conducted to bandpass filter **106**, low-noise amplifier (LNA) **108** and bandpass filter **110**. After that the signal is brought to block **112** which produces signal components having a 90-degree phase difference. The in-phase component I and quadrature component Q are further conducted by means of switches **114** and **134** to mixers **116** and **136**. The mixers get their mixing signals from a DCS synthesizer **140** the frequency of which corresponds to the received carrier frequency so that the mixing produces the in-phase and quadrature components of the complex baseband signal. The baseband signal is further processed in the receive (RX) signal processing unit, block **139**.

[0009] If the signal received is a USM signal, switch **104** directs the received signal to the GSM branch which comprises, connected in series bandpass filter **126**, low-noise amplifier **128**, bandpass filter **130** and phase shifter **132** which generates two signals with a mutual phase difference of 90 degrees. The signals are further conducted by means of switches **114** and **134** to mixers **116** and **136** where the mixing frequency is now determined by a signal coming from the GSM synthesizer **150** via switch **161**. The signals produced by the mixers are further conducted to the baseband RX signal processing unit **139**.

[0010] The DCS synthesizer comprises in a known manner a phase-locked loop (PLL) which includes a voltage-controlled oscillator (VCO) **141** the output signal of which is amplified at amplifier **146** thus producing the synthesizer output signal. The frequency of the signal from oscillator **141** is divided by an integer Y in divider **142** and the resulting signal is conducted to phase comparator **43**. Similarly, the frequency of the signal generated by reference oscillator **158** is divided by an integer X in divider **144** and conducted to phase comparator **143**. The phase comparator produces a signal proportional to the phase difference of said two input signals, which signal is conducted to a low-pass filter (LPF) **145** producing a filtered signal that controls the voltage-controlled oscillator **141** The phase-locked loop described above operates in a known manner in which the output frequency of the synthesizer becomes locked to the frequency coming to the phase comparator from the reference frequency branch. The output frequency is controlled by varying the divisor Y.

[0011] The GSM synthesizer **150** comprises a voltage-controlled oscillator **150**, amplifier **156**, dividers **152** and **154**, phase comparator **153** and a low-pass filter **155**. The GSM synthesizer operates like the DCS synthesizer described above, but the output frequency of the GSM synthesizer corresponds to GSM frequency bands.

[0012] In the transmitter part, a baseband complex transmit (TX) signal is processed in a TX signal processing unit wherefrom the in-phase and quadrature components of the signal are conducted to mixers **162** and **182** that produce a